



# Glaciology

## *Glacial Calving*

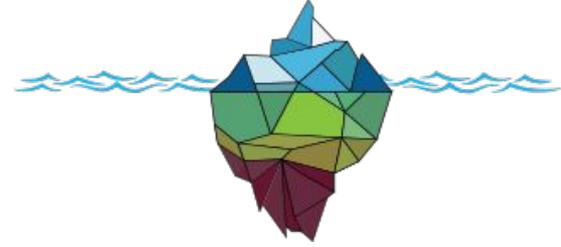


# What is Calving?

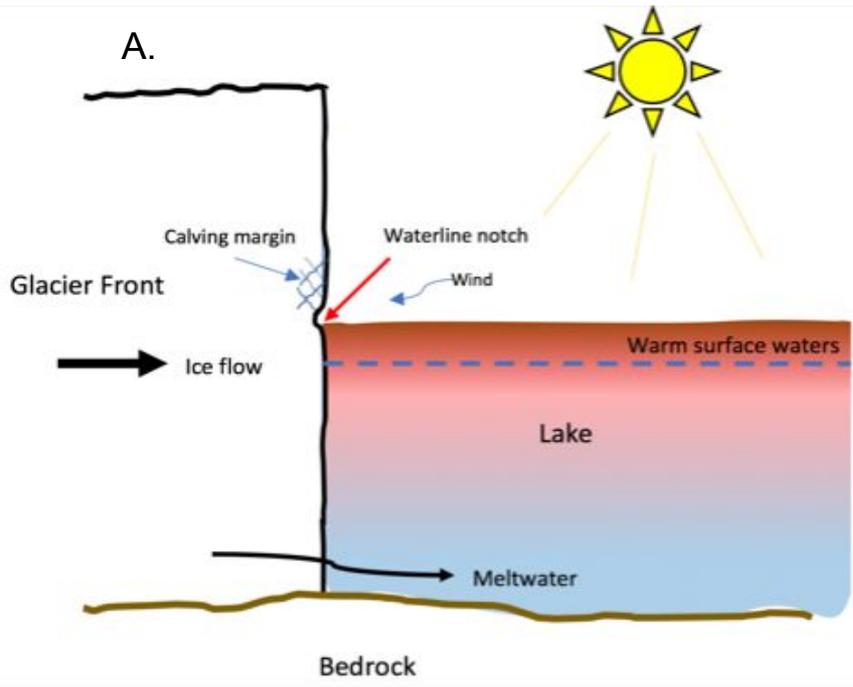
- Calving is defined as the mechanical loss of ice from glaciers and ice shelves
- When a glacier ends in water, a cliff is created
- If cracks at weak points in the ice can penetrate right through the glacier, bits of ice - *icebergs* - can break off



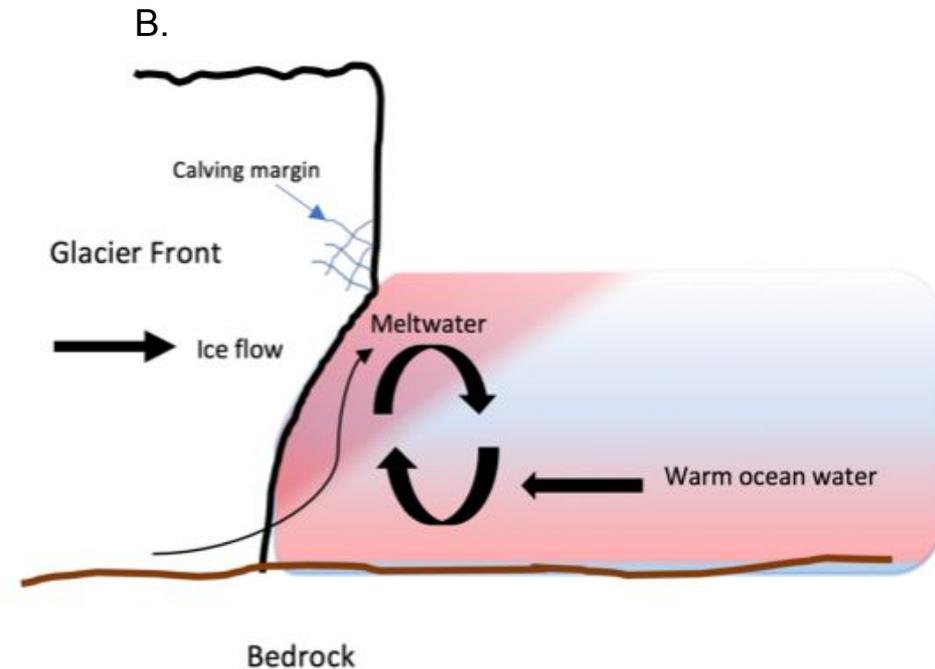
A glacial cliff courtesy of *A New American Paradigm*



## How does it work?

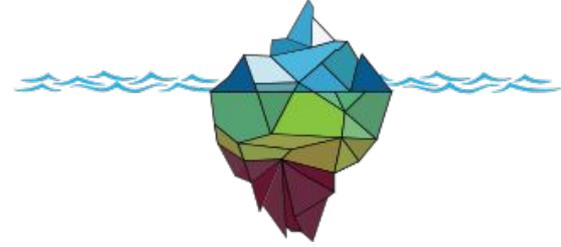


A. Calving at Lake Terminating glaciers. The sun warms the upper layers of the water which causes melt at a waterline notch and ice break-off.

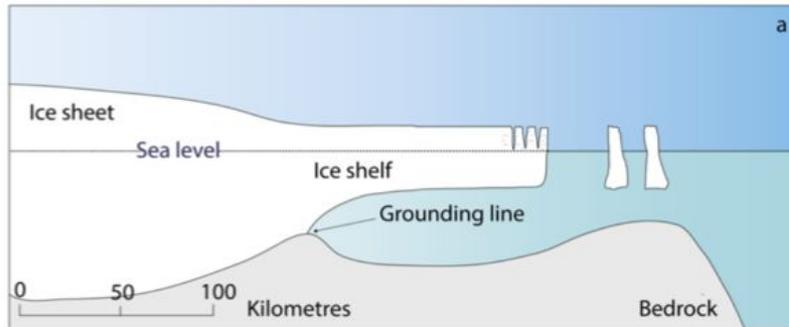


B. Calving at Marine Terminating glaciers. Warm ocean water undercuts the glacier creating an overhang which eventually breaks off.

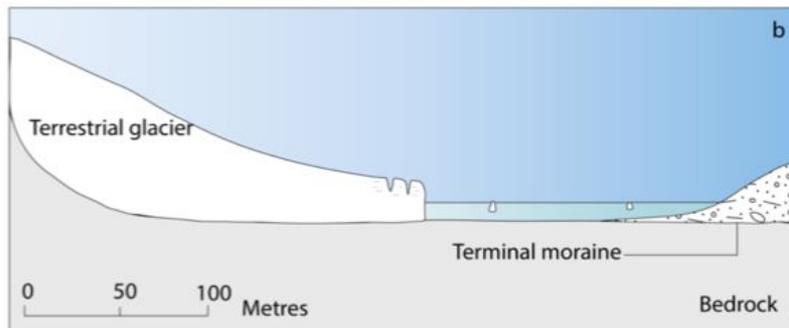
A simplified sketch showing melt undercutting at a) a lake-terminating and b) a marine-terminating glacier (C. Keane, 2018)



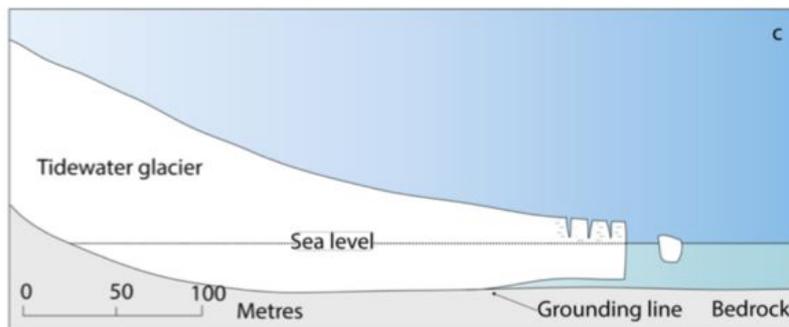
# Calving Margins



- a. Unstable ice shelf with bedrock which slopes downwards inland

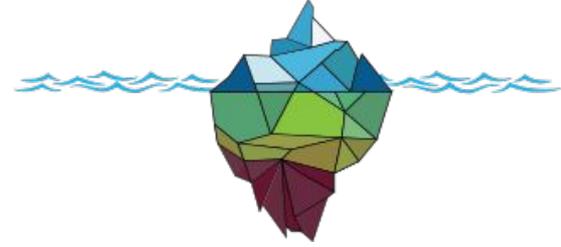


- b. Lake terminating glacier



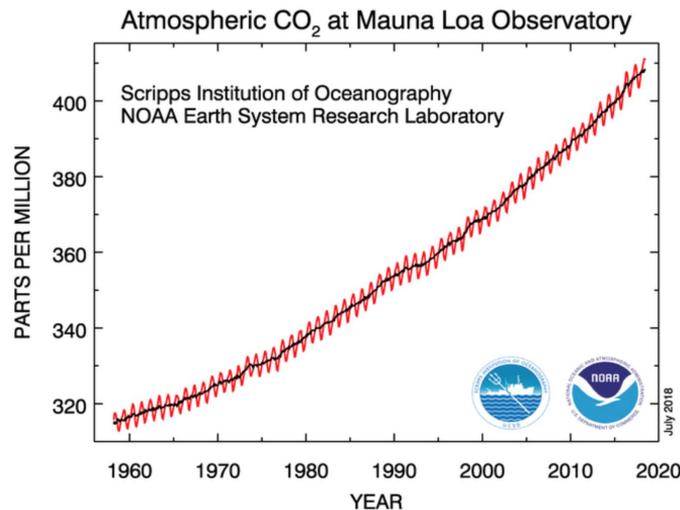
- c. Stable marine terminating ice sheet with a bed which slopes upwards

Simplified cross sections of different calving margins (Bell, 2017).

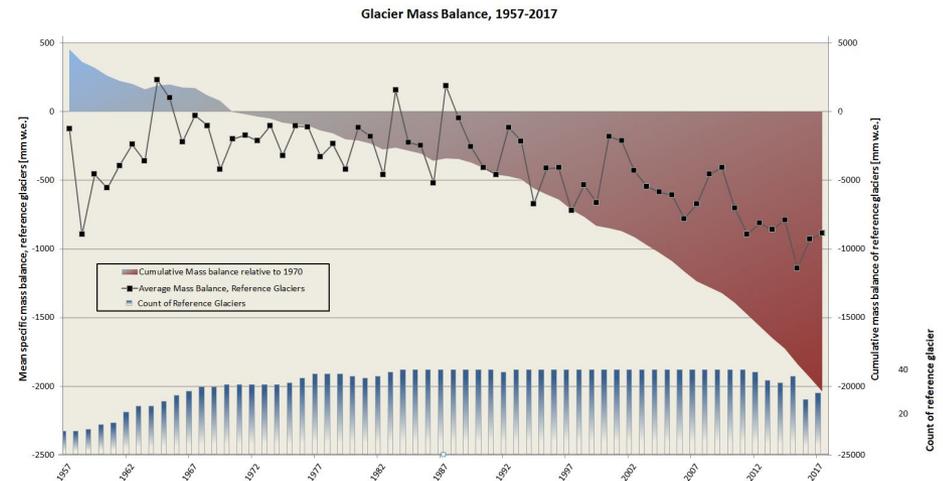


# Why is it important?

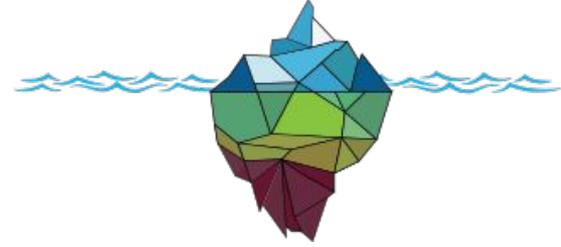
- *Calving* is a vital and effective ablation mechanism and thus a major component of the mass balance of many glaciers worldwide
- Since the 19th century, there has been a rapid increase in the rate of glacial recession, likely due to the global warming associated with increased concentrations of CO<sub>2</sub>



Graph of atmospheric CO<sub>2</sub> at Mauna Loa Observatory courtesy of the NOAA.

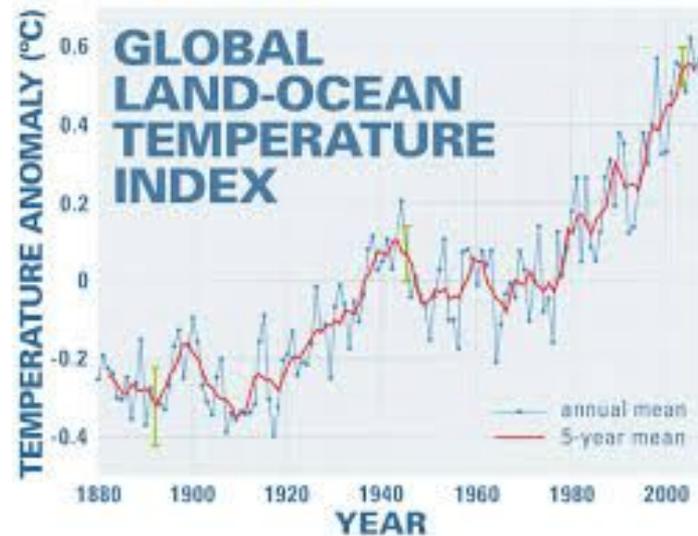


Graph of glacier mass balance over time courtesy of the global cryosphere watch.



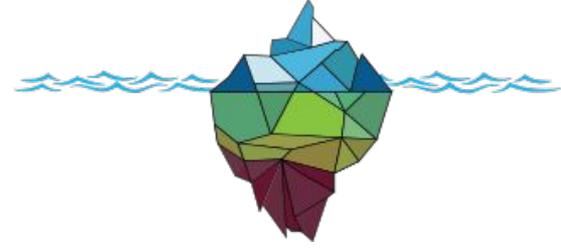
## Why is it important?

- Increased concentrations of CO<sub>2</sub> have caused air and ocean temperatures to rise



Graph showing the global land-ocean temperature index courtesy of NASA

- This has resulted in an increase in mass loss via supraglacial and subglacial melting and by iceberg calving



## Significance of Calving

- Calving accounts for up to 50% of the mass transfer from glaciers to the ocean
- *Accounting for ~70% of the mass loss from the Antarctic Ice Sheet and over 50% of the mass loss from the Greenland Ice Sheet*

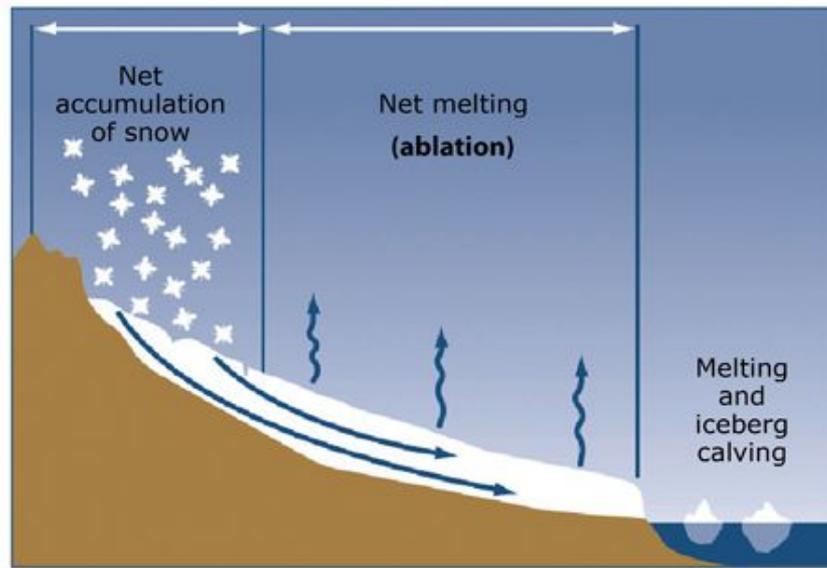
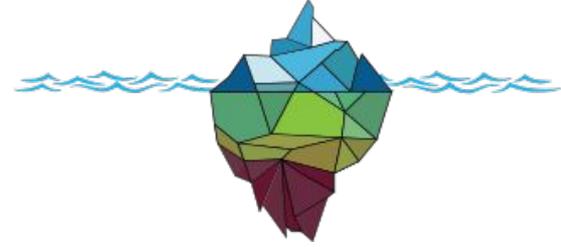


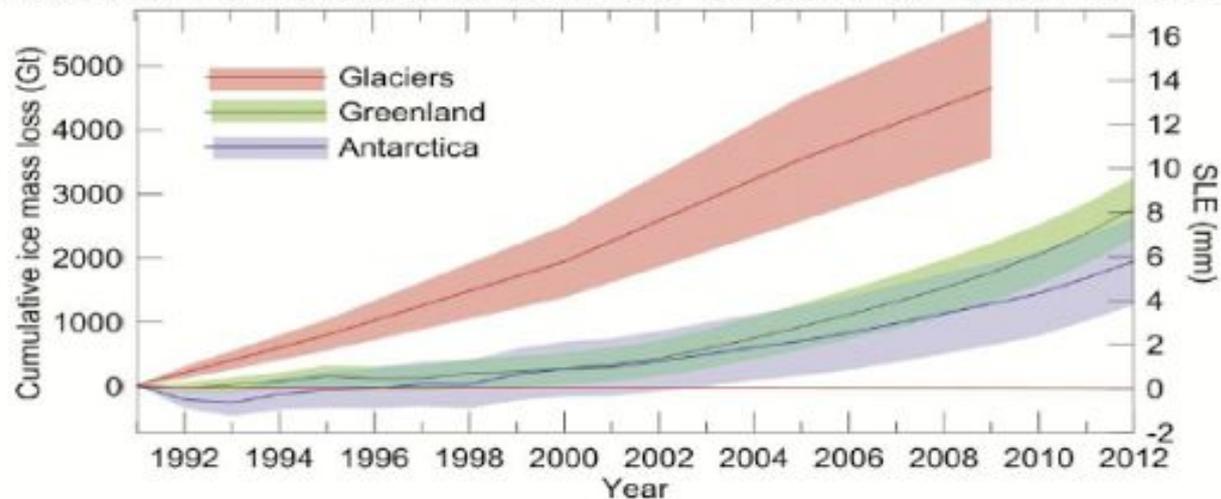
Diagram showing how calving contributes to the transfer of glacier mass to the ocean, courtesy of *Antarctic Glaciers*.



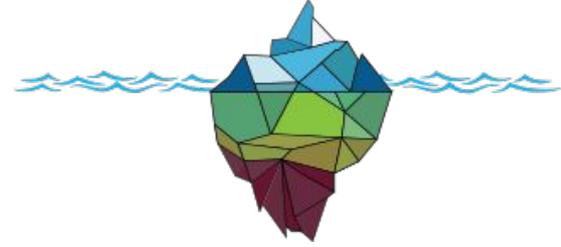
# Sea Level Rise

- As a result of this, calving contributes to global sea level rise in two ways:
  - 1) releasing icebergs into the ocean
  - 2) reduced resistance encourages increased ice discharge

## Contribution of Glaciers and Ice Sheets to Sea Level Change



Graph of the cumulative ice mass loss from glaciers and ice sheets in sea level equivalent (IPCC, 2013)



# Impacts of Calving

- As well as contributing to global sea level rise, calving is hazardous to human life and infrastructure
- Large icebergs can fall into water bodies and cause tsunami-like waves
  - These have the potential to flood nearby areas, destabilise ships and boats, and also injure tourists



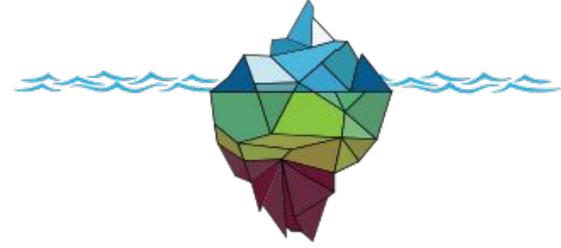
Cartoon of the Titanic hitting an iceberg courtesy of the National Geographic



# True or False

Calving is the breakoff of icebergs at the front of a glacier.

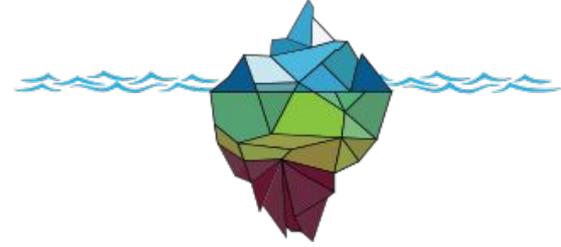
True or False



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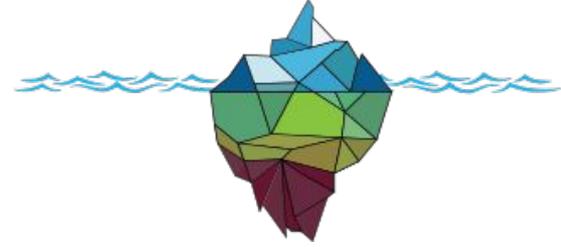
**True** or ~~False~~



# True or False

Calving is a minor component of the mass balance of glaciers worldwide

True or False

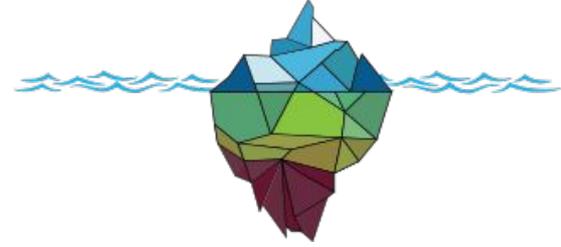


# True or False

Calving is a minor component of the mass balance of glaciers worldwide

~~True~~ or **False**

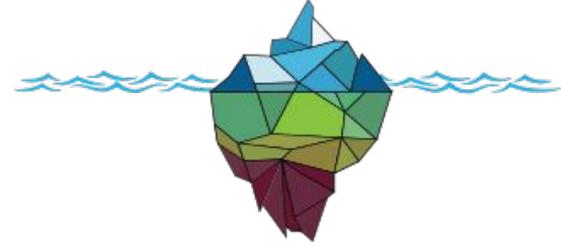
False! Calving plays a major role in the mass balance of glaciers worldwide as it is a key factor in *Ablation*.



# True or False

Calving has increased in line with global temperature increases, the result of increased concentrations of atmospheric CO<sub>2</sub>

True or False



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**True** or ~~False~~

